

V.B.3 Fuel Cell Installation and Demonstration Project, Gallatin County, Montana*

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**Congressionally directed project*

Objectives

- Demonstrate operation of a fully integrated distributed generation system consisting of a fuel cell generation plant, interconnection equipment and microgrid to provide the hydrogen industry and the general public with a high-technology real-world application of such a system.
- Determine the degradation rate of the fuel cells and the point at which it becomes economically necessary to “restack” by replacing the fuel cells.
- Provide operational data to Montana State University to assist in the development of control equipment to optimize fuel cell performance when combined with other electrical sources.
- Maximize efficiency of the heat recovery system.

Technical Barriers

This project addresses the following technical barriers from the following sections of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

Fuel Cells

- E. Durability
- F. Heat Utilization

Technology Validation

- I. Hydrogen and Electricity Coproduction

Education

- B. Lack of Demonstrations or Examples of Real World Use

Approach

- Construct suitable fuel cell installation site at a high-technology facility.
- Install redundant stationary fuel cells.
- Install heat recovery systems on fuel cells and integrate into building heating system.
- Operate fuel cells and heat recovery equipment according to manufacturing and engineering specifications as base load power supply and supplementary heat supply to building.

- Study/analyze performance and reliability of installed fuel cells, heat recovery equipment, interconnection equipment and microgrid based on operational data collection.
- Work in conjunction with Montana State University and others to enhance complementary fuel cell and microgrid studies.

Accomplishments

- Installed and began operation of two (2) FuelCell Energy DFC-300 molten carbonate fuel cells and heat recovery equipment.
- Completed Generation Interconnection Agreement with NorthWestern Energy allowing excess power to be transmitted back to utility electrical grid.
- Completed agreement with Belgrade Fire Marshall to comply with National Fire Protection Association (NFPA) Standard 853.
- Obtained Environmental Protection Agency (EPA) Site Identification Number to legally generate and dispose of hazardous waste produced by fuel cell natural gas purification system.
- No evidence of fuel cell degradation.
- Resolved or in process of resolving the following electrical integration issues:
 - Reconfigured fuel cells with neutral wire to make them compatible with building system.
 - Rebalanced electrical bus load and installed line reactors to reduce harmonics and meet fuel cell minimum load requirements.
 - Matched voltages of fuel cells and building back-up generators.
- Installed second back-up diesel generator to complete integrated system of fuel cells, electrical grid, diesel generators and uninterruptible power supply (UPS) systems providing five levels of redundancy for critical building functions.
- Developed solution to meet new load stabilization operating parameters when fuel cells operate in grid-independent mode. Identified and developed solution for related protective relay coordination issue.
- Proposed solution for protection of fuel cells down to -45° F.
- Determined that lower oxygen content of atmosphere at site elevation of 4,687 feet above sea level adversely affects performance.

Economic

- Negotiated separate natural gas supply and transmission contracts to keep input costs as low as possible in time of rising energy prices.
- Negotiated temporary agreement with NorthWestern Energy to price excess power transmitted to utility electrical grid.
- Fuel cell operation:
 - Reduced building utilization of utility electrical grid by 76.6%.
 - Reduced building utilization of natural gas for space and water heating by 52.3%.
- Negotiating with fuel cell manufacturer for affordable long-term service agreement.
- Current increases in price of copper and steel jeopardizing construction of microgrid and interconnection equipment.

Legal

- Established non-profit Galactic Electric Power Cooperative, Inc. (GEPC) to serve as ownership and operating entity for complete distributed generation system.

- Negotiating with NorthWestern Energy on permanent pricing agreement and territorial agreement allowing GEPC to legally serve customers in Subdivision.
- GEPC is applying to Rural Utilities Service/U.S. Department of Agriculture (USDA) for long-term, low interest financing of private cost share of project.
- Negotiating with Subdivision developer for start date for microgrid construction.
- Working with DOE on tripartite agreement to transfer Cooperative Agreement obligations from Zoot Properties, LLC to GEPC.

Future Directions

- Implement load stabilization and relay coordination solutions to allow operation of fuel cells in grid-independent mode.
 - Obtain approval from NorthWestern Energy to allow automatic reclosure of protective relay when fuel cells go from grid-independent to grid-dependent operation.
- Fine-tune operation of fuel cells and heat recovery system.
- Continue monitoring and analysis of fuel cell and heat recovery system performance.
- Implement cold weather protection solution.
- Install microgrid and interconnection equipment.
- Fine-tune operation of heat recovery system through installation of additional monitoring and control equipment and coordination with building systems.
- Complete territorial and permanent pricing agreements with NorthWestern Energy.
- Complete tripartite agreement with DOE.
- Complete affordable long-term service agreement with fuel cell manufacturer.
- Negotiate new contracts for natural gas supply and transmission.
- Obtain Rural Utility Service/USDA financing.
- Continue collaboration with Montana State University and other outside parties.

Introduction

This demonstration project is located on the 160-acre Galactic Park Subdivision seven miles west of Bozeman, Montana. Zoot Properties, LLC, owns the subdivision, headquarters building (building), fuel cells and other facilities identified in this report and is the “Cooperative Agreement” partner with the U.S. Department of Energy on the federal grants for the project. Construction of the building began in April 2001, and it was occupied in September 2002. It has a 55,000-square-foot basement parking garage and two upper floors totaling 100,000 square feet of office space. The building serves as headquarters to financial services company Zoot Enterprises, Inc. Customers of Zoot Enterprises, Inc. demand virtual “24-7” operation of the electronic data processing center located on the building’s first floor that is the heart of company operations.

Approach

In June 2003, two FuelCell Energy, Inc. DFC-300 molten carbonate fuel cells were installed adjacent to the building and serve as its base load power supply. The fuel cells are integrated with the NorthWestern Energy utility grid, two back-up diesel generators located in the building basement and UPS systems to provide five levels of electrical redundancy to the electronic data processing center, security and fire alarm systems and critical mechanical functions. Excess electricity from the fuel cells is transmitted back to the utility grid and is priced per a temporary agreement with NorthWestern Energy. We anticipate construction of the microgrid and interconnection equipment allowing transmission of excess power to the 160-acre Galactic Park Subdivision in the fall of 2004. When that construction is complete, it will

constitute a fully integrated distributed generation and transmission system.

Results

The principal issues faced in this demonstration have been fuel cell and heat recovery system performance and integration of the fuel cells with the building systems and the NorthWestern utility grid. There has not been any degradation in the performance of the fuel cells to date. A number of technical operational issues regarding the effects of the fuel cells on the building and the building demand on the fuel cells have been resolved, as indicated above. However, the main issue in this regard, grid-independent operation of the fuel cells, has not been resolved. FuelCell Energy will provide Zoot with a timetable for implementation of a product enhancement that, when implemented, will allow grid-independent operation of the units. In addition, as indicated above, technical issues regarding the interface of the fuel cells with the utility grid have yet to be resolved. Economic issues identified above to ensure ongoing affordability of the project have yet to be resolved.

Conclusions

The principal accomplishment of the project to date has been identifying the issues that those considering implementation of stationary fuel cell technology will face. Among them are operational/technical issues, regulatory issues, economic issues and legal issues. The fuel cells do not exist in isolation from the rest of the world. They only work as an integrated part of other systems, both internal to the organization to which they provide power and external to the outside electrical utility grid. The identification of those issues and their resolution and/or lack of resolution are likely to be the most significant accomplishments of this project.

FY 2004 Presentations and Collaborations

1. Advised the City of Great Falls, Montana on fuel cell technology and its application to city-owned facilities.
2. Advised L. A. Olson & Associates, Inc. engineering firm on the applicability of fuel cell technology to Indian Health Service facilities on Montana Reservations.
3. Presentation to the Montana Joint Engineers Conference.
4. Presentation to the Montana Electric Cooperatives Association Board of Directors.
5. Conducted tour of installation for U.S. Environmental Protection Agency.
6. Presentation to the Burton K. Wheeler Center, Montana State University, Conference on "Montana's New Electrical Future."
7. Conducted tours of installation for Montana State Auditor John Morrison, Montana Public Service Commissioner Greg Jergeson and staff from the Montana Department of Environmental Quality.
8. Presentation to Montana Public Service Commission and staff.
9. Participation in DOE Cost Analysis for Small Cogeneration Systems study conducted by Energy and Environmental Analysis, Inc.
10. Participation in DOE study of fuel cell installations conducted by Battelle Memorial Institute.
11. Ongoing collaboration with Montana State University (MSU) in providing operational data to its fuel cell research project as well as participation by MSU personnel in design, operation and evaluation of project.